TITLE: **Numerical Simulation of a Natural Gas-Swirl Burner**

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1. ABSTRACT

Introduction and Objectives: The general goal of the current research is the improvement and optimization of the mixing processes between the reactants in such a way to minimize the environmental impact of combustion systems. Any improvement in the combustion performance relative to pollutant formation, stability, and overall efficiency requires a careful study of the flow field and mixing processes, particularly in such a highly turbulent reacting flow. The scaling of pollutant emissions in industrial flames is very difficult because of the complex geometry of the burner and the many parameters involved. The experimental evidence is that each burner is a unique device and even small geometry changes can influence the level of emissions. Earlier studies showed that swirl flows require a detailed flow structure and specification of the inlet conditions. The fluid dynamic analysis is very useful to provide the preliminary information about the mixing process. Therefore, in this benchmark study, CFD simulations was used to acquire a close understanding of the flow, thermal, and composition fields in the primary mixing zone produced by swirl in a turbulent non-premixed swirling combustor.

Accomplishments: A turbulent natural gas jet diffusion flame at a Reynolds number of 9000, in a swirling air stream, was numerically simulated. The numerical computations were carried out using the commercially available software package CFDRC. The instantaneous chemistry model was used as the reaction model. The thermal, composition, flow (velocity), as well as stream function fields for both the baseline and air-swirling flames were numerically simulated in the near-burner region. The results were useful to interpret the effects of swirl in enhancing the mixing rates in the combustion zone as well as in stabilizing the flame**.** The results showed the generation of two recirculating regimes induced by the swirling air stream, which account for such effects.

Future Work: Results are to be analyzed thoroughly. The interaction of the flow field characteristics (including mixing and recirculation) with the combustion and emission characteristics is to be delineated. Final Conclusions are to be drawn. The present investigation will be used as a benchmark study of swirl flow combustion analysis as a step in developing an enhanced swirl-cascade burner technology.

2. LIST OF PAPERS PUBLISHED/CONFERENCE PRESENTATIONS

"Numerical modeling of a turbulent gas jet diffusion flame in a swirling air stream," *Journal of Engineering for Gas Turbine and Power*. (Article in Review)

"Effects of Swirl on the Combustion Characteristics of Natural Gas," *3rd Annual Rio Bravo/Rio Grande Environmental Conference*, February 20-23, 2002, South Padre Island, Texas.

"Numerical Modeling of a Turbulent Gas Jet Flame in a Swirling Air Stream," *ASME International Engineering Technology Conference on Energy/Combustion and Alternative Energy Symposium*, February 4-6, 2002, Houston, Texas.

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